

OTS: 60-41,527

JPRS: 5775

10 October 1960

## SOVIET NONFERROUS METALLURGY

No. 16

## SELECTED TRANSLATIONS

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Introduction

This is a serial publication containing selected translations of articles on nonferrous metallurgy in the Soviet Union. This report consists of translations on subjects listed in the table of contents below.

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a. The Conversion of Mining Enterprises to a Shorter Working Day and New Wage Schedule

Following is the translation of an article entitled "Perekhod Gornorudnykh Predpriyatiy na Sokrashchennyi Rabochiy Den' i Novyye Usloviya Oplaty Truda" (English version above) in Gornyy Zhurnal (Mining Journal), No. 5, May 1960, Moscow, pages 8-14.]

(1) Leninogorsk Polymetals Combine

T. P. Sazonov and Ye. S. Bulynko

The Leninogorsk Polymetals Combine had converted to a shorter working day and new wage schedule on 1 February 1959. This was preceded by a great deal of preparatory work, commenced as long ago as in September 1958.

All of the Combine's shops had participated in the discussion of the problem of a transition to a shorter working day and revision of the wages of the workers of nonferrous metallurgy.

Subsequently, in the fourth quarter of 1958, plans were drafted at the Combine for preparing the transition to a six-and seven-hour working day and a new wage schedule, and so were the organizational and technical measures for raising labor productivity, reducing production costs and equipment stoppages, improving technical supply, mechanizing the loading and unloading operations, etc.

In 1959 a reserve of caved-in and readied ore was created in the Combine's mines. The transfer of ore from the open-strip pit to an underground level for transport to the concentrator plant was organized. The system of unit-by-unit repair of grinding equipment was introduced at the concentrator plant, and the modernization of ball mills was completed. Individual links of the production process were automated. A great deal of work was accomplished to raise the skills of the workers. More than 300 stoping-group workers were graduated with the titles of blasting expert, scraper operator, loader operator, and electric locomotive engineer. The workers failing to fulfill their output quotas underwent training in schools of pace-setting experience and in skill-raising courses.

Monthly drives for an improvement in the organization of labor and production were conducted in the principal shops

of the Combine, and they had resulted in over 360 suggestions for improving labor productivity, expanding output capacities, cutting production costs, saving materials and electrical energy, and so forth.

The transition to a new wage schedule and the execution of the intended organizational and technical measures enabled the Combine to maintain normal and rhythmic operations despite the shortened working day and to attain an overfulfillment of its output plan, increase in labor productivity and in quality of production, reduction in production cost, and a sizable saving in materials.

Thus, at the Leninogorsk Ore Mine during the second quarter of 1959 ore extraction increased by 19 percent and labor productivity -- by 11 percent, while extraction cost declined by seven percent, compared with a like period in 1958. At the Ore Mine imeni 40th Anniversary of All-Union Lenin's Young Communist League ore extraction increased by three percent and labor productivity per mine worker -- by 4.5 percent, while extraction cost declined by 1.5 percent. In the concentrator plants ore processing increased by four percent and labor productivity -- by 12.5 percent, while ore processing cost declined by 12.5 percent.

The increase in gross output for the Combine as a whole amounted to 8.5 percent compared with the corresponding period of the preceding year.

At the same time, the employment total declined by 200 persons. Labor productivity per worker for the Combine as a whole increased by 11 percent, and the mean monthly wage rose 5.3 percent.

The transition to a new wage schedule at the Combine involved the introduction of seven-category wage schedule and seven-category occupational-wage lists. In December 1959 the reclassification of workers was totally completed. The greater part of the workers was classified into the 3rd, 4th, 5th, and 6th categories.

While the mean wage-category index prior to the revision of the wage schedule amounted to 5.64 for the Combine as a whole, after that revision it became equal to 3.55; here the values of that index for the Leninogorsk Mine are equal to 7.15 and 3.72, respectively; for the Mine imeni 40th Anniversary of All-Union Lenin's Young Communist League -- 6.85 and 3.6; for the Andreyevskiy Open-Strip Pit -- 5.07 and 4.27; for the concentrator plants -- 4.83 and 3.33; for the lead plant -- 5.24 and 3.9; and for the machine repair base -- 5.0 and 3.7. Prior to the transition to a new wage schedule, the Combine had to observe 8,540 different work quotas of which 49.1 percent were technically justified. After their revision the number of quotas decreased by 218, and the percentage of

technically justified quotas rose to 77.2.

During the first few months of work under higher output quotas the number of workers failing to fulfill their quotas had increased, which is basically to be explained by the sharp (as much as 67-percent) raise in output quotas for the individual types of mining operations (drilling with the KTSM-4 drill, collection of ore with scrapers, loading of ore by loaders, etc.) and by the stoppages of equipment and the unpunctual supplying of materials and equipment to workers.

In measure with the improvement in the organization of labor and material-technical supply, the workers began to fulfill these raised quotas and the heads of the Combine ceased to use the correction factor of 0.80 in their calculations.

Prior to the transition to the new conditions, the mean percentage of the fulfillment of quotas for the Combine as a whole amounted to 113.2 percent for the basic operations and 167.5 percent for the auxiliary operations, while after the transition it dropped to 103 and 120 percent, respectively.

The majority of the workers of the auxiliary shops and auxiliary sectors of basic shops began to be paid on the basis of the system of worked time or worked time plus bonuses instead of the previous piecework wage system. Out of the total number of workers in the production group 36.2 percent continued to be paid on the piecework basis, in which 26.8 percent continued to be paid on the piecework-plus-bonus basis, while the other 63.8 percent began to be paid on the worked time basis, in which 40 percent -- on the worked-time-plus bonus-basis.

The basic workers of the mines, concentrator plants and lead plant are paid on the piecework plus bonus basis. In the mines, the bonusing of workers is conducted according to the fulfillment of the plan of corresponding types of operations by mine sectors.

After the transition to a shortened working day and new wage schedule the mean monthly wage rose 6.5 percent for the piecework workers and 10.2 percent for the time workers. After the introduction of new conditions for the remuneration of labor the share of rated wages in the total wages amounted to 68.4 percent for the piecework workers and 78.6 percent for the time workers.

The mean monthly wage per worker in 1959 rose 2.8 percent compared with 1958 for the Combine as a whole, 2.4 percent at the Mine imeni 40th Anniversary of All-Union Lenin's young Communist League, and 2.5 percent in the concentrator plants.

As a result of the overfulfillment of its plan of gross

output in 1959 the Combine attained a saving of over five million rubles in its wage fund. The cutting of the production cost of all marketable output in 1959 had yielded a saving of 7.5 million rubles. The production cost of the comparable part of the output [i.e., of same products as those manufactured during preceding years and hence comparable] was cut 3.7 percent (against 2.6 percent envisaged in the plan). The savings in production cost were achieved mainly as a result of the overfulfillment of the plan and rise in the volume of output, benefits accruing from the reduction of the depletion of the content of metals in the ore processed in the concentrator plants, reduction of the norms for the consumption of materials, fuel and electrical energy, rise in labor productivity, introduction of new technology, etc.

In connection with the transition of enterprises to new working conditions and taking into account the operational experience of the Lenincorsk Combine, it would be expedient to:

(1) Award bonuses to labor brigades according to the percentage of fulfillment of extraction quotas, wherever the brigades are paid by the piecework-plus-bonus system and in the case that the percentage of fulfillment of extraction quotas is lower than the percentage of plan fulfillment, and conversely:

(2) Determine the percentage of bonus payable for a 100-percent fulfillment of the plan and for every additional percent above the plan, when the brigades are paid according to the system of worked time plus bonus. Here the total amount of the bonus should not exceed 20 percent of the monthly wage.

In our opinion, the materialization of these suggestions will positively affect labor productivity and the interest of the workers in a continuing rise in that productivity.

## 2. Zyryanovsk Lead Combine

V. N. Finogenov

Most of the shops of the Zyryanovsk Lead Combine had converted to a shorter working day and new wage schedule as of 1 February 1959. In June 1958 wage-classification commissions were established in all shops of the Combine and the additional number of workers necessary for a normal operation of the continuous-production sectors was calculated. New cadres of workers were readied for these sectors. Many workers

had raised their skills greatly. Altogether, 968 persons were trained in the basic shops of the Combine.

Frequent orientation conferences were held for the heads of shops, shop workers, members of shop wage-classification commissions, and workers of the mechanical computer center. The whole of the preparations for transition to a shorter working day and new wage schedule was directed by the Combine's central commission.

As a result of the thorough preparations for the conversion to a shorter working day and new wage schedule, it was possible to ensure the fulfillment and overfulfillment of the output plan in its basic indexes (see Table).

Table

Basic Indexes of the Fulfillment of the Output Plan at the Zyryanovsk Combine

Index	Fulfillment of plan in percent		Increase in percent
	1958	1959	
Ore extraction	104.7	102.3	100.8
Mine development work	114.1	106.2	82.6
Ore Processing	103.5	103.2	103.0
Overburden-stripping work	100.6	91.9	151.1
Output of			
Lead Concentrates	107.3	104.1	95.0
Zinc Concentrates	112.2	109.1	95.1
Recovery of metal into mono-type concentrates of			
Lead	100.6	101.3	100.8
Zinc	100.4	100.4	95.1
Content of metal in mono-type concentrates of			
Lead	102.7	109.8	105.1
Zinc	100.2	101.0	101.1
Production cost of marketable output	97.5	99.0	101.8

The slight decrease in the output of concentrates is to be explained by the decrease in the metal content of the extracted ores.

The figures for 1959 show the total recovery of zinc (sulfidic and mixed and for 1958 -- the recovery of sulfidic zinc only (mixed zinc was not planned)).

Compared with the actual 1958 indexes.

The transition to a shorter working day and new wage schedule involved a revision and raise of the effective output quotas by: 9.2 percent for mining work; 35.8 percent for auxiliary shops; and 16.5 percent for the Combine as a whole.

As a result of a number of organizational and technical measures, the fulfillment of the new higher output quotas by individual workers and whole brigades now reaches 130 and more percent, and the percentage of workers failing to fulfill their quotas has dropped from 6.8 to 6.2.

The rise in labor productivity in 1959 compared with 1958 totaled in percent: at the Maslyanskiy Mine -- 17.1; Zyryanovsk Mine -- 3.8; Grekhovskiy Mine -- 9.5; Zavodskiy Mine -- 1.2; and for the Combine as a whole -- 21.1.

As a result of the introduction of unit-by unit repair system, combination of occupations, transfer of conveyer belts in the filter department of the concentrator plant, transport of loads in containers, rubberizing of rapidly wearing parts of flotation machinery, installation of presses, introduction of pneumatic drilling, and other measures, the Combine was able in 1959 to free 495 persons, to increase greatly labor productivity, and to cut production cost in excess of the plan. The production cost of ore extraction dropped by 5.5 percent in the Combine's mines in 1959 compared with 1958, and in terms of the share of wages in that cost by 18 percent. At the Maslyanskiy Mine the production cost dropped correspondingly by 9 and 17.4 percent, respectively.

### 3. Sorskij Molybdenum Combine

V. P. Tikhomirov

As of 1 November 1958 the Sorskij Molybdenum Combine converted to a shorter working day and new wage schedule. This was preceded by a great deal of preparatory work by the Combine's crew.

An especially organized commission received over 370 suggestions purporting to eliminate stoppages, mechanize labor-consuming operations and improve working conditions.

A seven-category wage list with five groups of wage rates was introduced. The mutual ratio of the lowest and highest categories in the groups is as follows: first group -- 1:2.85; second group -- 1:2.60; third, fourth and fifth groups -- 1:2.44. The classification of workers into this or that group was conducted according to the complexity and conditions of work.

The old wage schedule was retained for the workers

engaged in logging and wood cutting and in capital construction. Motorized transport (except for the dump trucks engaged in hauling bulk rock), the printing establishment, computer bureau, housing and communal management, guard system, kindergartens, and the local electric power station, were all converted to the shorter working day but on retaining the old effective output quotas and rates.

The work on determining the wage rates for workers proved to be particularly laborious and complicated. For this purpose, commissions were organized in the Combine's shops. Every worker was classified into a new category and assigned a new wage rate and placed under the most expedient wage system. The distribution of workers by categories of the wage list and in percent of the total number of workers is illustrated in Table 1.

Table 1  
Distribution of Workers by Category  
in Percent of Their Total Number

Category	1	2	3	4	5	6	7	8	9	10	Out-side the Category
Before wage Revision	0.1	0.6	6.5	22.0	28.1	16.8	13.8	1.7	0.5	1.6	Motor vehicle drivers
After wage Revision	6.5	15.9	25.7	20.2	17.0	4.1	10.	-	-	-	

Locomotive engineers, their assistants, and stokers

Upon the introduction of the new wage system the share of rated wages in total wages rose to 71.0 percent from 59.1 percent among those paid by piecework and to 80.3 percent from 70.2 percent among those paid for time worked. After the revision of the wage schedule the wage rate per worker rose; for the open-strip pit as a whole -- by 34.2 percent; for the concentrator plant -- by 40 percent; and for the motorized transport hauling the mined bulk rock -- by 57 percent.

The raising of the rated wages made it possible to con-

vert a great number of workers from the piecework system of remuneration to the time-worked-plus bonus system: in particular, forge workers, hammer wielders, lathe turners, fitters, planing-machine operators, fitters-electricians in machine shops, repair fitters, carpenters and drivers engaged in various (random) operations, and all workers of the concentrator plant as well.

The effective output quotas were re-examined. New quotas, after their careful drafting and technical justifications, were subjected to broad discussion. For the Combine as a whole the output quotas were raised 32 percent, and for the basic operations alone -- 27.3 percent, and for the auxiliary operations alone -- 38.4 percent, and the share of the operations remunerated according to quotas based on time-study observations and technical calculations amounted to 68.3 percent.

As a result of the introduction of technically justified output quotas, the overfulfillment of the output quotas decreased substantially but the volume of output increased (see Table 2).

Table 2

Fulfillment of Output Quota at the Sorskiy Combine, in percent

Subject	First Half of 1958	First Half of 1959	Number of Workers Failing to Fulfill New Output Quotas
For the Combine as a Whole	151	120.3	7.6
In which: by Basic Shops			
Ore Mine	158	111.8	16.1
Central Repair and Machine shop	189	125.4	4.3
Mine transport	148	122.8	6.3
By Basic Occupation			
Excavator operators	138	108.4	25.0
Drillers	186	113.0	11.1
Bulldozer operators	151	110.2	0.9
Mine transport drivers	134	104.0	14.0

The underfulfillment of output quotas by some of the workers is to be explained mainly by the low skill of individual workers who had only a limited work experience, and partly

also by organizational and technical reasons (lack of electrical energy, water, drilling bits, spare parts).

On 1 November 1958 the previously effective progressive-piecework wage system was abolished. At present all piece-work workers in the leading occupations have been converted to the piecework-plus-bonus wage system. The bonuses are paid on the condition of the fulfillment of the output norms and the stipulated plan of the sector, brigade and machine group.

A worked-time-plus-bonus wage system for the fulfillment and over-fulfillment of output plans and for the improvement of qualitative indexes was introduced for the workers paid for time worked. In particular, this system has been introduced for the on-duty personnel of mine production sectors and for the auxiliary personnel servicing the piece-workers as well. It has also been introduced at the concentrator plant and oxygen plant for the time-paid workers of the electromechanical service, power installations and other sectors and shops. The piecework pay system has been retained for the workers of the central machine shop, timber-cutting sector, and the workers engaged in loading and unloading operations and in the repair of buildings and structures.

The distribution of workers by form and system of remuneration of labor is illustrated in Table 3.

Table 3

**Distribution of Workers by Form and System of Remuneration of Labor, in percent of the Total Number of Workers**

Remuneration of Labor	Conditions of Remuneration of Labor	
	Old	New
Straight piecework . . . . .	43.5	16.5
Progressive-piecework. . . . .	24.7	-
Piecework plus bonus .. . . . .	-	27.7
Indirect piecework . . . . .	1.0	-
Total, piecework	69.2	44.2
Worked Time	11.0	9.2
Worked Time plus bonus	19.8	46.6
Total, Time-Worked System	30.8	55.8

As a result of the revision of output norms and wage rates the mean wages of workers in the basic and auxiliary

shops remained on the previous level. The wages of the workers of the concentrator plant, mine, and mine transport, rose slightly.

Operating Indexes of the Sorskiy Combine After the Switch to a Shorter Working Day and New Wage Schedule, in percent of 1958

Gross Output . . . . .	129.8
Ore Extraction . . . . .	105.5
Overburden-stripping Work . . . . .	100.0
Retreatment of Ore . . . . .	105.4
Output of Molybdenum Concentrate . . . . .	129.5
Output of Copper Concentrate . . . . .	307.5
Mean Wage . . . . .	103.6
Output of Mined bulk rock per bore. hole meter . . . . .	109.5
Number of Workers . . . . .	98.7

4. Dzhezkazgan Mining Administration

L. S. Pamyatnykh

In September 1956 a new system of labor remuneration was introduced for underground workers in the mines of Dzhezkazgan, and in October it was extended to all other mine workers. The old system of labor remuneration was retained for the capital-construction workers, rail-transport loading workers, and truck drivers. The conversion to the new system involved a revision of the wage rates and of the output norms so as to increase them by 10 percent for the basic operations and by 22.3 percent for the auxiliary operations.

The work on the revision of wage rates continued throughout 1957. In November of 1958 the wage schedule was refined in connection with the introduction of the seven-category wage list, and the majority of the workers was then classified into the 5th, 6th and 7th categories. At the same time, the rated wages for underground operations were raised 65 percent, for auxiliary operations -- 29 percent, and for the Mining Administration as a whole -- 40 percent. The share of the rated wages in the total wages of workers climbed from 63.5 to 80-82 percent.

A major part of the pieceworkers in a number of production and auxiliary sectors where it is difficult to establish precise output quotas and to calculate the volume of conducted operations, was converted to the worked-time-

plus-bonus pay system. The volume of operations paid on piecework basis declined from 57 to 43 percent.

On underground operations piecework pay was retained for drillers, scraper operators, loader operators, chute-drawer men, locomotive engineers, dosers, and bin tenders; on mine surface, this pay system was retained for lathe turners, forge workers, hammermen, and partly also fitters and electric welders. All other workers were converted to the worked-time and worked-time-plus-bonus pay system.

Under the new system of labor remuneration the worker's wage has begun to depend on the fulfillment of the production program, which has sharply affected the increase in ore extraction.

The finely graduated scale of progressive extra payments (reaching 400 percent) for the overfulfillment of the output quotas was replaced by a two-graduation scale (reaching 200 percent). The extra payments for the overfulfillment of output quotas were replaced by progressive extra payments for ore extracted in excess of the plan established for the brigade or for the number of meters of headway tunneled in excess of the plan. Under the old system of progressive extra payments, integrated brigades operating with a smaller number of workers used to overfulfill greatly their output quotas, which led to excessive expenditures on wages. The brigades were not interested in extracting ore in excess of the planned amount. The previously existing custom of paying only 50 percent of the progressive extra payments in the event of the underfulfillment of the plan by a brigade did not attain its purpose. At present, the assigned tasks are not revised for a brigade operating with a smaller number of workers, but they are appropriately revised for a brigade operating with a larger number of workers.\*

The revision of the wage rates was accompanied by a revision of the technical norming of output quotas, as expressed in the conduct of a certification of the equipment of the central repair and machine shops, introduction of technically justified output quotas for drilling and scraper operation, increase of the output quotas for mining operations, and drafting of quotas for integrated brigades based on payment per ton of extracted ore and per specific number of meters of tunneled headway.

\*If the task assigned to a brigade corresponds with the plan-quota, it has to be revised if the brigade operates with a smaller number of workers, as otherwise the regulations for remunerating their labors are violated. EDITOR

Data on the fulfillment of the output quotas and wage rates for individual occupations after the revision of the wage system are cited in the table below.

Table

Fulfillment of Output Quotas, and Wage Rates  
in the Mines of the Dzhezkazgan Mining  
Administration

Occupation	1956 (Before Reform)	1957	1959 (first 10 months)
Fulfillment of Quotas, in percent			
Drillers	110	105	110
Scraper operators	114	110	111
Tunnelers	131	118	112
Workers of basic shops	132	118	118
Monthly wage, in rubles			
Drillers	1875	2320	2430
Scraper operators	1555	2240	2120
Tunnelers	2420	2770	2065

The revision of the wage system has played a considerable role in the increase in ore extraction and labor productivity and in the reduction of production cost.

Operating Indexes of the Dzhezkazgan Mining  
Administration

	1956	1957	1958	1959 (10 months)
Increment in ore extraction, in percent of the previous year	-	25.0	12.4	7.9
Labor productivity in terms of mined bulk rock, in m <sup>3</sup> per shift, for:				

	1956	1957	1958	1959 (10 months)
Stoping-group worker	4.5	5.25	6.46	6.80
Underground worker	2.0	2.34	2.62	2.84
Shaft worker	1.53	1.80	1.99	2.03
Mining-administration worker	1.01	1.27	1.43	1.68
Production cost per ton of ore, in percent	100	96.0	88.7	85.5

The rise in labor productivity and mastering of output quotas were fostered by the conduct of organizational and technical measures such as the replacement of 0.3-and 0.5-m<sup>3</sup> scrapers by cast scrapers with capacities of 0.4 and 0.8 m<sup>3</sup>, the use of rock ammonite, the time-delay blasting of boreholes, etc.

## b. New Stoping Technology for the Mining of Vein Deposits

Following is the translation of an article by M. I. Agoshkov and A. F. Nazarchik entitled "Novaya Tekhnologiya Ochistnoy Vyyemki pri Razrabotke Zhil'nykh Mestorozhdeniy" (English version above) in Gornyy Zhurnal (Mining Journal), No. 5, May 1960, Moscow, pages 14-18.<sup>7</sup>

The tin mines of the Khrustal'ninskiy Combine in the Primorskiy Sovnarkhoz have mastered a new technology of mining vein deposits under difficult mining-geological conditions and within a relatively short period of time, and the scale of their output has increased considerably. In their principal production indexes these mines have attained the level of the pace-setting ore mining enterprises of the USSR.

In 1958, when the research in a radical perfection of stoping technology was commenced, the labor productivity per stoping-group worker at the Khrustal'nyy Mine Complex reached 2.4 m<sup>3</sup> of ore per shift, and the rate of headway in stope, based on the shrinkage-stoping system (Fig. 1) amounted to 8-10 meters a month. These indexes were 30-40 percent higher than in the other pace-setting mines working vein deposits.

A major role in these achievements was played by the lengthy creative collaboration of the workers of science and industry, a broad approach to joint scientific research and industrial experiments in mines. Since 1951 the workers of the Khrustal'ninskiy Combine and the Institute of Mining, Academy of Sciences USSR, have been conducting joint studies of ways and means of developing new systems of the mining of vein deposits and improving old systems of this kind. These studies resulted in the mastering of mining systems based on: layer shrinkage stoping of ore; complete shrinkage stoping and strut propping; separate extraction of ore and shrinkage of fill; and downward stoping with filling of the worked-out space. This was accompanied by improvements in the techniques and parameters of drilling and blasting operations during stoping, in the removal of the cut ore, in the methods of propping the enclosing rocks, and in the organization of labor.

The gradual perfection of elements of mining systems and of the technology of individual operations has been logically accompanied by a rise in labor productivity and in the intensiveness of the mining and extraction of ore, and by a decline in extraction costs. The labor productivity per

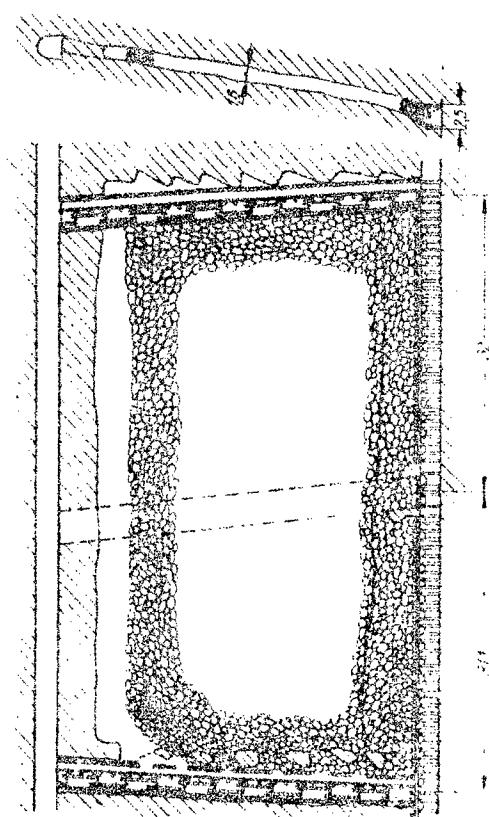


Fig. 1. Shrinkage Stoping  
System at the  
Kostel'nyy Mine  
Complex

stoping-group worker in the Combine's mines has been increasing by an average of 20 percent a year and at the beginning of 1959 it nearly tripled in comparison with 1951 (see Table), and extraction cost declined more than twice while extraction has been increasing.

In addition to the improvement of mining systems, the work on perfecting individual processes of stoping and of the organization of labor has been consistently furthered. The Institute of Mining, Academy of Sciences USSR, jointly with the workers of the Khrustal'ninskiy Combine and Primorskiy Sovnarkhoz, conducted studies on the use of blast holes with a smaller diameter (34-36 mm) when mining ore in a narrow stope. This made it possible to increase greatly the labor productivity of drillers and to reduce appreciably the depletion of ore in quality.

Table

Rise of Production Indexes in the Mines of the  
Khrustal'ninskiy Combine

Mining System and year	Labor Productivity per Stoping-Group Worker, in m <sup>3</sup> per shift	Stope Headway Rate, in met- ers per month
Overhand-stoping system with strut props (1950- 1951)	1.2	4-5
Layer Shrinkage Stoping (1951-1952)	1.8	7-8
Complete Shrinkage Stoping (1955-1958)	1.8 - 2.4	8-10
System with Complete Shrinkage Stoping and New Stoping Technology (1959)	10 - 12	30 - 40

During the working of thin veins by the shrinkage-stoping system, which is the most widely used system in the indigenous mining practice, one of the most labor-consuming operations is the discharge of ore from blocks. This operation accounts for 41.6 percent of the total labor input involved in stoping. To reduce the laboriousness of this operation, the experimental work conducted in 1957-1958 involved the development of new versions of systems with: discharge of ore

through chute drawers onto the floor of the drift, with subsequent gathering by a scraper on the lower horizon; and discharge through contiguous chute drawers. Both versions have successfully passed their tests in the mines of the Combine.

At the same time the organization of labor in the integrated stoping brigades in the mines of the Combine began to be altered with the view of including the largest possible number of stoping processes into the integrated whole of operations and attaining the maximal interchangeability of workers.

The experience gained, and the results achieved, in joint studies, the newly obtained results of scientific researches and analyses of the laboriousness of stoping operations, and the appearance in industry of new drilling and blasting techniques and equipment have together created the possibility of new, radical improvements in the technology of stoping which would make it possible within a short period of time to raise considerably the labor productivity of stoping-group workers -- not by 20 percent a year as in the past but at least twice or thrice a year, and moreover, to mine ore vein blocks within one or two months instead of five or six months.

The project of stoping technology drafted by the collective of scientists and production workers was based on such an improvement of all stoping processes as would not only cause the change in the technology of every operation to be accompanied by a reduction in its direct labor input but also simultaneously promote a decline in the labor input of the other operations. Such a path of perfecting the operations of the technological process could be termed "coordinative-integrating." The drafting and discussion of the plan and methods of research in the mines of the Khrustal'-ninskiy Combine in April 1959 was followed by the initiation of experimental work in several blocks of the Volkovskaya Vein.

The quartz-cassiterite Volkovskaya Vein measuring from 0.05 to 0.4 meter in thickness and having an angle of dip of 70-75 degrees, occurs in compact clay shales and sandstones. The strength of the ore and enclosing rocks amounts to 10-12 points on the Protod'yakonov Scale.

An integrated brigade of miners headed by M. N. Boyko mined blocks 40 meters high and 60 meters long by the shrinkage stoping system by straight-on tunneling throughout the length of the block (see Fig. 1). Blast holes were drilled with new PT-29 telescopic rapid-percussion drills manufactured by the "Kommunist" Plant in Krivoy Rog. According to data of time-study observations, the use of the new drills increased the rate of blast-hole drilling to 48-49 cm/minute compared with 40 cm/minute for the conventional PT-45 drills.

Blast holes 1.8 meters deep were drilled simultaneously

at four or five places in the block by four or five drills. The blast holes were aligned in three series in chessboard order, with distance between the series amounting to 0.5-0.6 meter. The distance between the blast holes in a series was taken at 0.6-0.7 meter, as in customary block drilling. At such an arrangement of blast holes the ore proved to be comminuted during breaking (lumps with size of less than 100 mm accounted for 60-70 percent of the mined bulk rock, and lumps with size of more than 300 mm were nearly completely absent), and the side rocks were subjected to an intensive crack formation and exfoliation. Theoretical calculations and practical observations during the experiments in the mines indicated that the spacing of blast holes in a series should be increased to 1.0 meter. When this measure is taken, the yield of ore lumps larger than 300 mm remains nearly unchanged but the yield of ore fines (smaller than 100 mm) decreases to 30-35 percent and the depletion of ore quality decreases by 5-10 percent.

Thanks to this more rational spacing of blast holes, labor productivity during ore cutting rose from 6-8 to 10-13 m<sup>3</sup> per shift. Further, after the brigade headed by M. N. Boyko had switched to drilling of blast holes by bits with diameter of 36 mm instead of the 44 mm normally applied in the local mines, the drilling rate increased to 49.2 from 22 cm/minute. As a result, labor productivity in drilling rose by more than 80-90 percent.

The relationship between the change in drilling rate and the diameter of the blast hole (Fig. 2) is, according to experimental data, much stronger than is indicated by the known formula  $v_1 = v_0 \left(\frac{d_0}{d_1}\right)^2$

The drilling of blast holes with a 36-mm diameter has made it possible to increase the drilling rate greatly, and the transition to blast holes with 32-diameter (see Fig. 2) results in nearly doubling the drilling rate.

This should be kept in mind when conducting the broad industrial introduction of the improved stoping technology in the mines working vein deposits, whenever a reduction in the diameter of drilling bits is not hampered by a lack of the necessary equipment and materials. This requires a sufficient supply of cross-and chisel-shaped drilling bits with diameter of 28-30 rock drill steel with diameter of 18-19 mm, powerful explosives (of the type of detonites and rock ammonite) in cartridges of 24-26 mm diameter, and lightweight rapid-percussion telescopic drills with noise silencers.

Coupled with the reduction in blast-hole diameter, the industrial-scale use of new cross-shaped drilling bits with a discontinuous serrated? edge has sizably influenced the

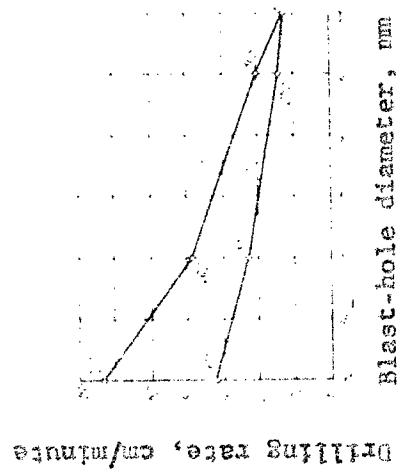


FIG. 2. Relationship Between Drilling Rate and Blast Hole Diameter

1. According to experimental data;
2. According to the quadratic dependency formula.

decrease in the labor input required by stoping operations. Experimental lots of these bits were manufactured by the Kiev Experimental Hard-Alloy and Diamond Tool Plant. The replacement of chisel-shaped bits by these new cross-shaped bits, of an identical diameter, resulted in an 18-25 percent increase in drilling rate. The use of the new bits has proved particularly effective when drilling blast holes in crumbling rocks, in which the chisel-shaped bits display low production indexes and cause a considerable consumption of hard alloy.

In experimental blocks blast holes were exploded with a new powerful explosive -- "detonite."\* The high brisance and efficiency of that explosive make it possible to manufacture it in small-diameter cartridges and, as a result, to fill the blast holes with more elongated charges ensuring a sufficient degree of crushing within a constructed stoping space. Measurements of extracting capacity in experimental vein blocks, conducted upon breaking ore with blast holes of the conventional and the reduced diameters, demonstrated that the use of explosive charges with 28-mm diameter results in reducing the width of stoping space by 15-20 cm compared with its width at the use of 32-mm charges and by 20-27 cm compared with its width at the use of 36-mm cartridges. This made it possible to extract less-depleted ore and thus to reduce the outlays on the removal and transport of ore and its beneficiation at the concentrator plant.

In addition, the use of detonite coupled with a wider spacing of the grid of blast holes resulted in raising sharply labor productivity at ore breaking to 13-18 from 8-10 m<sup>3</sup> per shift, and in reducing the consumption of explosives by 30-40 percent.

During the experiments, blast holes were exploded by the pyro-electric method, on using electric firing pin fuzes. The order of sequence of the explosion of charges was regulated by the length of the cords connected in a bunch to the fuze.

In addition to the drastic rise in labor productivity of the workers of the stoping group and appreciable decline in the depletion of ore quality, the consumption of electrical energy and compressed air per ton of extracted ore had also decreased. These indexes, in turn, resulted in a considerable reduction of the cost of the extraction and processing of ore.

The broken ore was discharged from the block through

\*The qualities of "detonites" are described in detail in an article by I. Ye. Sitnikov and A. T. Kazakov in "Gornyy Zhurnal," No. 3, 1960 -- EDITOR

chute drawers aligned in a continuous series along the block (see Fig. 1). Such an alignment of discharge chutes was adopted on the basis of the results of numerous time-study observations of the discharge of ore through variously spaced chutes. An analysis of these observations showed that the new scheme of discharge of ore through contiguously aligned chutes ensures a uniform settling of the shrinkage-stopped ore throughout the entire length of the vein block, prolongs the interrepair period of service of chutes, reduces the number of the wedgings of ore in the vein block, and reduces the number of delays of loaded mine-car trains.

Thanks to the new scheme of contiguous alignment of chutes, the labor input involved in the discharge of ore dropped to 5.5 from 16.8 minutes per  $m^3$ , and the labor productivity of the stoping-group workers rose by another 80 percent.

The entire membership of the integrated brigade under M. N. Boyko servicing the vein block has successfully mastered all the occupations of stoping workers. Every brigade member has learned to drill blast holes with one or two drills, discharge ore, prop up the raises, dismantle and clean drills, install air and water supply facilities, and manipulate the winch when supplying the vein block with timbering and materials. Over one-half of the brigade's workers has mastered the occupation of the blaster, and has charged and exploded the blast holes.

All the daily processes of ore extraction were executed during two six-hour shifts according to an operational graph (Fig. 3). During the pauses in between the shifts the vein block was ventilated, and repairs were conducted.

During the first shift four workers operating with rapid-percussion drills drilled through the first half of the vein block for five hours. During the same period of time, three workers located in the other half of the vein block completed the trimming of the stope, discharge of excess amount of broken ore, and propping of raises.

During the last, sixth hour of the shift, the drillers charged and exploded the blast holes while the proppers started delivering props and materials.

During the first five hours of the second shift the proppers discharged ore, dismantled the stope and propped the raises in the first half of the block, while the drillers drilled through the second half of the block. If the drilling was successfully completed sooner than anticipated by the graph, the relieved workers participated in the propping or in the discharge of ore.

The labor productivity reached during the experimental operations was exceptionally high -- 10.5  $m^3$  of ore per stop-

ing-group worker per shift, and so was the rate of stoping headway -- about 40 meters a month. These indexes are the highest ever reached in the practice of the Soviet mines working vein deposits.

Therefore the new stoping technology began to be intensively introduced in the ores of the Primorskiy Sovnarkhoz. The share of the extraction performed by the new technology amounted at the Khrustal'nyy Mine Complex to 49 percent of the total ore extraction during the second quarter of 1959, and 84 percent during the third quarter of that year. In December 1959 it reached virtually 100 percent. At the Tsentral'nyy Mine ore extraction based on the new technology accounted for 46 percent of the total extraction during the third quarter of 1959, and in December 1959 that mine had switched completely to the new technology.

Upon the introduction of the new ore stoping technology, labor productivity of mine workers rose by more than 30 percent at the Khrustal'ninskiy Combine. The relatively low increase in this index is to be explained by the fact that there labor productivity of mine workers is calculated in terms of the amount of ore provided to the concentrator plant, whereas the labor productivity of the stoping-group workers alone is determined by the amount of the shrinkage-stoped ore, which is partly discharged from the blocks and partly stored in them.

At present, the switch to the new technology has been made not only by the mines of the Khrustal'ninskiy Combine but also by the Primorskiy Mine Complex of the Sikhali Combine, and it is being completed by the Verkne-Kentsukhinskiy Mine Complex of the Dal'-Olovo Combine. The resulting rise in labor productivity and in the rate of stoping headway has been accompanied by a sharp decrease in production costs as well.

The new stoping technology can find widespread application in all the Soviet mines exploiting vein deposits by systems with shrinkage stoping of ore and open stoping space, considering that these systems account for about 80 percent of the total extraction of ore from vein deposits at present.

The principles underlying the creation of the new technology of the stoping of vein deposits are also of great methodological interest to the planning of efficient mining systems and the improvement of the technology of the stoping of large ore deposits.

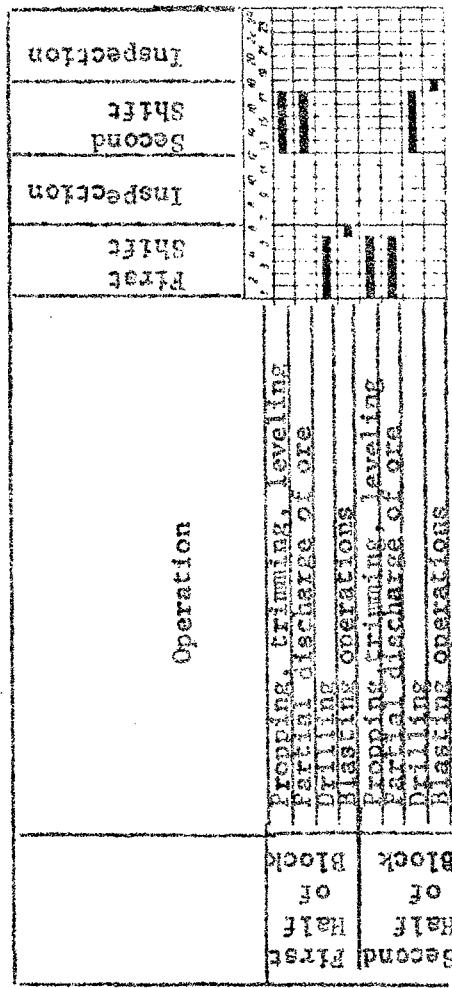


FIG. 3. Graph of the Organization of Operations in N. N. Boyko's Brigade

c. The Third Plenum of the Central Board of the  
Scientific and Technical Society for  
Nonferrous Metallurgy

Following is the translation of an article by V. A. Frolov entitled "Tretiy Plenum Tsentral'nogo Pravleniya NTO Tsvetnoy Metallurgii" (English version above) in Gornyy Zhurnal (Mining Journal), No. 5, May 1960, Moscow, page 75.

The Third Plenum of the Central Board of the Scientific and Technical Society for Nonferrous Metallurgy, convened in February 1960 in Leningrad, discussed the results of the fulfillment of the plan of introduction of new technology in 1959 and the principal tasks of the Society for 1960 with regard to further technological progress in the enterprises of nonferrous metallurgy.

One hundred and sixty persons participated in the activities of the Plenum.

Upon listening to the reports on activities in 1959 and plan for 1960 of the Central Board of the Society (report by V. F. Fedorov) and the Leningrad Branch Board of the Society (report by F. T. Malenko), and upon listening to the report of T. F. Kharlamov about the introduction of new technology in the enterprise of nonferrous metallurgy in the RSFSR during 1959, the participants of the Plenum shared their experience and pointed out the principal shortcomings in the Society's activities and made valuable recommendations and suggestions for improving the work of the Society.

One major shortcoming mentioned was the absence of a proper control by the Society of the introduction of new technology, and of the Society's recommendations as to the development of new technology.

A. N. Shilin (Unipromed') /Institute for the Design and Planning of Copper Industry Establishments/, A. P. Semynin (Gosplan RSFSR), and Ya. D. Pakhomov (Yakutskiy Sovnarkhoz) turned the Plenum's attention to the impermissible delays in the improvement of mining technology. Underground mines and open-strip pits should be provided with new equipment satisfying the modern requirements, and the Society should foster this.

The technical trends of the improvement of production technology should be reflected in the plan of activities of the Society for 1960. The participants at the Plenum recommended to the Society's Central Board that it should hold creative discussions about concrete problems (bulk flotation of polymetal ores, etc.).

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Noting that the Society's activities during the report period were oriented toward providing practical assistance to enterprises of nonferrous metallurgy in their fulfillment of the plan of the first year of the seven-year period and in accelerating technological progress, the Plenum pointed out that the shortcomings in the Society's operations as revealed at the Conference, were one of the reasons for the underfulfillment by certain enterprises of the time schedules for the introduction of new technology.

The Plenum approved the budget and plan of activities of the Central Board for 1960 and outlined concrete measures for improving the work of the Society.

END

FOR REASONS OF SPEED AND ECONOMY  
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